REVIEW OF ‘MAINTENANCE PLANNING BASED ON RELIABILITY ASSESSMENT OF MULTI-STATE MULTI-COMPONENT SYSTEM’

TRAVIS C. MALLETT

Abstract. This is a post-publication review of the article “Maintenance Planning Based on Reliability Assessment of Multi-state Multi-component System” presented at the *2018 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)* in Bangkok, Thailand. The review summarizes the article and explains its overall strengths and impact. The article is found to be a novel contribution to the field of reliability analysis, but the results may be severely limited by the many assumptions in the paper. The review raises many major points that need clarification in the article. The methodology and assumptions are specifically challenged as real systems will not likely conform to the simplified degradation path assumed by the authors. The review also points out several minor points which should be addressed.

1. Overall summary of the article and its findings

This paper [1] outlines a plan for maintenance planning and warranty planning using a model which considers multi-state and multi-component degradation.

2. Overall strengths of the article and its impact in the field

The title is very clear and accurately includes all the necessary information to understand the topic of the paper. The paper provides a good introduction to the background. As the authors state, there are very few attempts in the literature to assess system reliability considering dependent nature of components. This is a novel contribution to the field. The results are promising but may be severely limited by the assumptions. The author of this review rated the paper on Publons with the following metrics. Quality: 6.0, Significance: 7.0, Overall: 6.5.

3. Major points which need clarification, refinement, reanalysis, and rewrites

(1) The abstract clearly defines the topic, but it does not mention any results of the application. Please reference some results (e.g., the improvement in warranty cost from the example on page 6: \$230). The abstract also does not clearly describe a clear problem statement.

T. C. Mallett is with Schweitzer Engineering Laboratories, Inc. in Pullman, WA. This review was published by Publons on August 12th, 2020. DOI: 10.14322/PUBLONS.R8893350.

Such a problem statement is found in the Introduction: The problem statement is given in the introduction “Most of the business organizations experience a lot of challenges while providing with comprehensive product warranty due to additional costs associated with it.” Please include the problem statement in the abstract and then use the abstract to advertise the proposed solution (and results).

(2) Out of the fourteen references, only two are from recent years. There are many references over 10 years old. I am not confident that the authors performed a sufficient literature search as part of this research. Additionally, most of the references are to various topics not directly related to the methodology described in this paper. The authors should find additional references which relate to the reliability assessment of multi-state multi-component systems (this paper only refers to three previous works, and one of them is already 10 years old at the time this paper was submitted).

(3) Some statements in the introduction can be simplified to make the point clearer. For example: “An inference about brand reliability was made by Boulding & Kirmani, (1993)[3] using the results obtained from an experimental study. The study confirmed the dependence of buyer’s purchase decision and brand reliability on warranty scope and manufacturer reputation” could be simply stated: “It was confirmed by Boulding & Kirmani [3] that buyer’s purchase decisions and perception of brand reliability depend heavily on the warranty scope.” Please work on the introduction section to make it more readable and succinct.

(4) The problem statement is given in the introduction “Most of the business organizations experience a lot of challenges while providing with comprehensive product warranty due to additional costs associated with it.” This problem statement can be worded more clearly and could also be located closer to the beginning of the introduction to clearly describe the main challenge that is addressed by this research.

(5) The methodology divides degradation modes into two categories: independent deterioration and dependent deterioration. However, there is at least a third option: the correlation between the deterioration due to both the dependent correlative effects of component degradation and the independent degradation processes. That is, while I agree that the authors calculated the proper Total System Transition Probability in equation (7) based on their assumptions, practical systems will have dependence between the two degradation categories. For example, component 1 may degrade independently and thus affect degradation in component 2. However, component 2’s degradation characteristics may now change as a result of component 1’s influence in a way that is not captured by the degradation pattern $M_x \to M_{x-1} \ldots$ The authors should provide additional analysis on the complex interactions between the degradation categories.

(6) The authors state several assumptions at the beginning of the paper. However, there is no justification for these assumptions. And, in fact, these assumptions may severely limit the accuracy of the model and hence the results are called into question. For example, the authors assume that only a single transition occurs during one time instant. This, of course, is far from reality. The authors also assume a successive pattern of degradation that progresses in only one direction. However, real systems can see multi-directional transitions between degradation states. Furthermore, degradation states may be traversed in more random sense than implied by the successive pattern assumed by the authors. The authors use a Markov process which assumes each transition is independent of the previous state. Unfortunately, real systems are not always so considerate to simplified analysis. The authors should provide additional justification for each of these assumptions and clearly outline the limitations of the research. As-is, I am skeptical about the applicability of the research to real-world problems since the limitations could end up being crippling without additional analysis.

4. MINOR POINTS ABOUT FIGURES/TABLES, REFERENCES, TYPOS, AND OTHER INCONSISTENCIES.

(1) All the equations are inserted as pictures. Please type these into the document properly. This is especially necessary for the matrices on pages 2 and 4 where the subscripts are blurred and almost impossible to read, even while zooming in. Additionally, these matrices should be given equations numbers. Please re-format as necessary. Layout may be improved by making these matrices Tables and referencing them accordingly.

(2) The journal style is to have the references listed in the order they are cited. The first citation in this paper is [13], and the numbering does not match the required convention. Furthermore, the paper includes two (2) citation methods for each in-line citation! Both "Author(s) (year)" and IEEE [#] styles are given each time. Please fix this issue and follow the IEEE style manual.

(3) The conclusion provides a good summary of the research, but it sounds largely speculative: The plan "can" reduce the cost; The plan "can" increase reliability. The authors can impart more confidence by supporting these statements with the results which demonstrate the benefits of the research.

REFERENCES

[1] N. Jain, A. P. S. Rathore, R. Jain and O. P. Yadav, "Maintenance Planning Based on Reliability Assessment of Multi-state Multi-component System," *2018 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM),* Bangkok, 2018, pp. 262-267, DOI: 10.1109/IEEM.2018.8607526.